



Adoption Behaviour of Climate-resilient Agricultural Practices in Punjab under NICRA Project

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ABSTRACT

An integrated package of climate-resilient technologies was demonstrated in one village per 4 selected districts namely Bathinda, Faridkot, Roopnagar and Fatehgarh Sahib of Punjab. The major objective was to augment the resilience of agricultural systems, both crop production and livestock farming to climate vulnerability. From 2011-2020, major interventions made in crop production system were; crop residue management, zero tillage, quality seed, green manuring, biofertilizers and promotion of water saving technologies such as laser land levelling, direct seeded rice, short to medium duration rice varieties, etc. Major interventions made in livestock production system included green fodder production round the year, silage making, mineral mixture, uromin lick availability and regular vaccinations. To improve livelihood, subsidiary occupations like dairy farm, backyard poultry, piggery, jaggery production and protected cultivation units were established in the NICRA villages. Farmers were highly convinced to adopt the recommended practices but adoption level of demonstrated natural resource management technologies was variable and specific to a district. The satisfying results were witnessed under the NICRA project and there was an increase in the adaptive capacities, and enhanced incomes. NICRA villages functioned as model villages and became knowledge hubs/centres for out-scaling technologies in large areas.

INTRODUCTION

The climate change refers to long-term changes in either the overall climate of the earth or in regional climate over time. Since the evolution of the world, climate has been gradually changing at its natural pace, but recently, it has accelerated due to unanticipated disturbances from human activity. Change in climate is a natural phenomenon that can be brought on by changes in the earth's atmosphere (such as glaciations, ocean variability, etc.) or by natural occurrences (such as volcanism, plate tectonics, solar variation, orbital variations, etc.). Experts have concluded that

global climate change can have an impact on the crop production yields and climate change must be dealt with caution and system approach for attaining food security (Howden et al., 2007; Tripathi et al., 2016).

Climate variability has variable impact on agriculture at regional or global scale. It is very imperative to evaluate linkages between agro-ecosystems, unpredictable climate change, impact on crop growth and food security in the long run (Parry & Carter, 1989). A change in climatic variable may have a positive or negative effect on agricultural productivity at a particular situation (Greg et al., 2011). The impact of climatic variability on agricultural productivity,

particularly in developing countries has been well-documented (Gunathilaka et al., 2018). It is crucial to take action to encourage farmers to adopt climate-resilient agricultural technologies so that they can cope with the adverse impacts of climate change and variability (Pabba et al., 2022). Factor for success of any agricultural technology/practice modelling is the high demand for institutional support for smallholder farming households (Shitu et al., 2018). The need for climate-resilient agriculture and efficient use of natural resources such as water and soil are brought into greater perspective by heat/cold stress and unpredictable rainfall in Punjab, which is an important food grain growing state in India. As a response to these challenges, both research and farming community developed a wide range of agro-techniques that could enhance the resilience of agricultural system to change in climate (Wezel et al., 2014).

The Indian Council of Agricultural Research (ICAR) launched a network initiative of 'National Innovations in Climate Resilient Agriculture' (NICRA) in February 2011. The project consisted of four components: strategic research, capacity building, technology demonstration and sponsored or competitive grants (Singh & Venkateswarlu, 2011; Hadiya et al., 2020). The programme also incorporated the current best practices for climate resilience as well as put an emphasis on the need for infrastructure development for monitoring climate change scenarios across field conditions at important research institutes (Suresh & Vishvanthan, 2022). The NICRA project has been implemented in four districts of Punjab with the purpose of enhancing the resilience of agriculture at farmer's field with the demonstration of improved technologies through extension units. The impact of various climatic-resilient technologies in the field of crop and livestock production systems in Punjab was studied after the 10 years of adoption of NICRA project in a particular village.

METHODOLOGY

Drought and heat waves were primary considerations in the selection of districts, Bathinda and Faridkot. Frost and cold waves were primary climatic variability in Fatehgarh Sahib and Roopnagar. Under NICRA project, KVKs selected villages, held stakeholder meetings and carried out baseline surveys. KVK Bathinda selected village Kili Nihal Singh with total cultivated area of 810 hectares. KVK Faridkot selected village Pindi Balochan with a total cultivated area of 1060 hectares. KVK Fatehgarh Sahib selected the village of Badaucchhi Kalan where total cultivated area was 952 hectares. KVK Roopnagar selected five villages- Rashidpur, Fatehgarh Viran, Rampur Fasse, Mohan Majra and Behrampur bet with total cultivated area of 853 hectares.

During this project, State extension agencies and ICAR-ATARI (Agricultural Technology Application Research Institute) played a pivotal role in village development plans. To ensure farmers' participation in the project, VCRMC (Village climate risk management committees) were formulated in the villages. The members of ZMC (Zonal Monitoring Committee) and VCRMC collectively gave suggestions to scale up the climate resilient technologies for the benefit of farming community. KVKs conducted demonstrations, awareness camps, trainings, TV-radio talks, field visits, and farmer-scientist interactions.

From 2011-2020, major interventions made in crop production system were crop residue management with different machinery

such as happy seeder, baler cum knotter etc., zero tillage, quality seed, green manuring, promotion of water saving technologies such as laser land levelling, direct seeded rice and kitchen gardening. Regular animal vaccination and use of mineral mixture/ uromin licks in animal feed were the major interventions made in livestock production system. After a period of 10 years (during 2021), survey was done among the adopting farmers to evaluate the impact and outcomes of these activities. Adoption rate, a key performance indicator of a particular technology was quantified to estimate the popularity and acceptance of that technology by farmers in a particular village/district.

With a participatory approach, constraints in agricultural productivity were recognised. For this purpose, the possible reasons for poor adoption were listed by the farmers. The social and economic reasons was prepared and distributed among twenty farmers from each selected villages for ranking of the reasons. The econometric analysis of this data was done by calculating Rank Based Quotient (RBQ) using the following formula:

$$RBQ = \frac{\sum_{i=1}^n (n+1-i^{th})}{N \times n} \times 100$$

Where, f_i = number of farmers reporting a particular reason under i^{th} rank; N = number of farmers; n = number of reasons identified

RESULTS AND DISCUSSION

Adoption of climate-resilient technologies

Before the KVK's interventions through the NICRA project, farmers were reluctant to use the new technologies or practices. With the positive results of technologies and the awareness programmes run by KVKs, farmers were encouraged to adopt new techniques which contributed to climate-resilient agriculture. The adoption of these climate-smart agricultural practices was site-specific. Not every agro-technology was successful at every location and there was no practice of 'one size fits all'.

Each and every farmer in Bathinda and Faridkot villages (98-100%) adopted laser land leveller technology as it helped them in saving water more efficiently (approximately 25-30%) and increased crop yield by 5-8 per cent as compared to conventional sowing. In case of Roopnagar (58%) and Fatehgarh Sahib (41%) districts, farmers adopted laser land levelling technology (Table 1). The perceptions of the farmers for the possible benefits of laser land levelling varied which caused the varied rate of its adoption by farmers (Larson et al., 2016). Kumar et al., (2022) also found that a large number of farmers assumed that it helped in reduction of irrigation cost and better fertilizer use efficiency in Sirsa and Karnal districts of Haryana.

Almost 75 per cent of Bathinda farmers adopted DSR technology (Table 1). This technology allowed Bathinda farmers to save 18-25 per cent of irrigation water as well as overcoming the problem of farm labour shortage. Similar results were reported by Singh et al., (2021) that DSR technology has the benefit of facilitating better weed control and timely rice establishment. DSR technology proved its potential to provide higher net returns in comparison to conventional puddled transplanted rice. DSR also prevents puddling, transplanting, and retaining standing water during

Table 1. Adoption of different interventions/technologies in the adopted districts

Interventions	Percent adoption of technology in various districts			
	Bathinda	Faridkot	Fatehgarh sahib	Roopnagar
Laser land levelling	99	98	41	58
Direct seeded rice	75	6.6	13	2
Alternate wetting & drying in transplanted rice	-	-	-	-
Zero tillage	65	49	2	7
Happy seeder	70	3.4	35	31
Baler cum knotter	75	58	-	3
Quality seed	70	70	-	-
Mineral mixture/uromin licks	55	55	5	66
Kitchen garden	85	85	100	72
Crop diversification	-	-	-	-
Animal vaccination	45	64	100	70
Green manuring	14	23	7	10

- indicates no success in adoption of technology after demonstrations

the first two weeks after seedling transplantation. While, only 13 per cent of the farmers in Fatehgarh Sahib district adopted DSR and farmers reported poor crop establishment due to heavy soil texture. In Roopnagar district, only 2 per cent of the farmers used this technology because of sandy soil which was not suitable for DSR. Weed management was the biggest problem in lower adoption of DSR as expressed by the farmers of Faridkot district. Although alternate wetting and drying in rice is the most promising climate-smart water management practice for reducing water use and decreasing methane emissions, farmers of every district did not adopt this technology. Farmers quoted availability of free electricity for tubewell connection as the main reason for negligible success in adoption of this technology.

About 65 per cent and 49 per cent of the farmers had adopted the zero till drill in Bathinda and Faridkot districts (Table 1). This was mainly ascribed to the low cost of cultivation. While, only 7 per cent of farmers in Roopnagar and 2 per cent of farmers in Fatehgarh Sahib adopted the zero till drill. This lower rate of adoption was due to the perception of farmers that zero till wheat will result in lower grain yield. Majority of farmers in Bathinda district have adopted happy seeder technology due to positive points, such as saving of irrigation water up to 15-20 per cent, increased yield due to micro atmosphere, reduction in environmental pollution and improvement in carbon in the soil. It was also observed that 35 per cent of farmers adopted Happy Seeder in Fatehgarh Sahib. Farmers were of the opinion that happy seeder technology has higher potential for adaptation in coping with heat stress. While, 31 per cent of Roopnagar farmers were convinced to use happy seeder technology as crop residue management due to the higher cost of machinery and the low window of operation (approximately 25 days). The major reason for less adoption of this technology in Faridkot area is the poor establishment, expertise to run machinery, problem in drill calibration and fear of risk of crop failure. Majority of the farmers in Bathinda (75%) and Faridkot (58%) had adopted baler-cum-knotter for the management of paddy straw. New factories were introduced in the district for lifting the bails. While in Roopnagar, very few farmers have used baler-cum-knotter technology due to high cost involved and lack of linkages with factories during these 10 years of NICRA project.

In the selected villages, farmers were reluctant to go for crop diversification. In Punjab, rice-wheat is the predominant cropping system and its diversification is restricted due to want of political will, ecology, lack of infrastructure (such as processing plants, dryers, cold storage) market forces and social preferences of the farmers. The farmers with high land holding and annual income level were having higher adoption levels of crop-resilient agricultural technologies compared to the other farmers due to frequent contacts with extension personals, the ability to invest more capital in agricultural practices, and were eager to explore new technology (Naik et al., 2023). While, majority of farmers in the smart villages adopted kitchen gardening in Fatehgarh sahib, Bathinda, Roopnagar and Faridkot districts (Table 1). KVKs provided vegetable kits and guided them about the importance of organic vegetables. The major reasons for high adoption of kitchen gardening were low cost and easy availability of vegetable seeds for establishment of nutrition garden at household level, a savings of approximately Rs 18000 per year for a family of four, and nutritional security. Similar findings were confirmed by Ojha & Singh (2019). After the training and demonstration, the dietary pattern and food habits of the villagers improved positively. As a result of KVK interventions, adoption of recommended variety has increased to the tune of 85 per cent during *kharif* and 98 per cent during *rabi* season.

Free vaccination programme initiated by KVKs resulted in a high vaccination adoption rate with 100 per cent in Fatehgarh Sahib and 70 per cent in Roopnagar avoiding any outbreaks whereas, 64 per cent got vaccinated their farm animals under the guidance of KVK in Faridkot (Table 1). Only 45 per cent farmers of Bathinda district had vaccinated their animals because of their fear, milk production may decline due to vaccination. Only 23, 14, 10 and 7 per cent of the growers in Faridkot, Bathinda, Roopnagar and Fatehgarh Sahib districts, respectively adopted green manuring due to the limited availability of seed, non-availability of electricity at the time of sowing and attack of tobacco caterpillar at initial stage.

More than 60 per cent of farmers in Roopnagar regularly feed mineral mixtures and uromin licks for higher production. In Bathinda and Faridkot, 55 per cent of the farmers adopted mineral mixture, while these supplements were used by only 5 per cent in Fatehgarh

Sahib. Through usage of supplements, problem of repeat breeding has been overcome to a large extent. This resulted in increase in milk production and reproductive potential in dairy animals. In Faridkot and Bathinda districts, farmers were cultivating a few crops for fodder purposes, such as jowar, bajra, rye grass etc. before the initiation of the project. KVKs in both districts provided quality seeds for fodder crops like maize and berseem and area under fodder crops were increased to 6.6 per cent during 2021. KVKs provided quality seeds of maize, jowar, bajra and oats that yield higher and produce rich silage. Farmers were convinced about the purpose of quality seeds and there was change in behaviour towards quality seed. In the beginning, the number of biogas plants was low because villagers were unaware of their benefits. However, following the NICRA project and subsequent motivation to the growers, farmers were convinced for establishment of biogas plants with the help of government departments.

Impact of NICRA project

Impact analysis revealed that NICRA interventions increased resilience at the farm, household and village levels. These agro-technologies helped farmers to cope with extreme weather conditions like drought, frost, cold and heat waves. During the period of NICRA project, farmers were made aware of various improved agro-technologies. Adoption level of natural resource management technologies such as zero-tillage, happy seeder, direct seeded rice and straw balers has increased in these four districts. Since 2012, area under zero tillage and happy seeder has been increasing day by day.

Demonstrations on various technologies were conducted at KVK farm to serve the purpose of showcasing the technology to farmers who frequently visited KVK for various reasons and sensitizing them for its adoption. The milk production in NICRA village has also increased by 20-25 per cent due to adoption of these interventions. Pindi Blochan, a village in the district of Faridkot was declared a burning free village in 2016. The information from the pollution control board and remote sensing supported the low level of residue burning. This might be due to implementation of climate resilient improved varieties together with better water and healthy soil management techniques.

Plausible reasons for poor adoption of particular climate-resilient technology

The constraints in the adoption of any novel agricultural technology included nature of the technology, the way in which it is conveyed to the farmers and the attitude and perception of the farmer about the technology. It was observed that among the various socio-economic reasons, higher cost of inputs with RBQ of 79.50, followed by psychological mindset with RBQ of 75.83 were the main reasons for poor adoption of particular crop residue management technology as mentioned in Table 2. Growers have varying perceptions that there will be poor and uneven germination of wheat crop and ultimately it will reduce yield of crop. They preferred to follow the conventional practices of clean cultivation.

Small and marginal farmers have less active participation in extension activities (technology demonstrations) as compared to big farmers. After discussion with the peers (big farmers), they

Table 2. Ranking of social and economic constraints for poor adoption of particular climate-resilient technology

S. No.	Social and economic constraints	RBQ	Rank
1	High cost of inputs/ machinery	79.50	I
2	Lack of linkages with extension functionaries	64.40	IV
3	Lack of empathy for environment	40.60	IX
4	Psychological mindset	75.83	II
5	Topography/climatic variability	52.00	VI
6	Peer pressure	54.10	V
7	Lack of technical guidance/expertise	40.33	X
8	Social bindings	70.20	III
9	Marketing uncertainty & fluctuations	50.00	VII
10	Stereotype nature	48.17	VIII

expressed satisfaction for a particular technology. Small farmers learnt about the technology from the experiences in their surroundings (seeing is believing). Due to lack of experience, these farmers were not so optimistic about new advancements in agriculture sector. Generally, farmers tend to rely on the opinion of the fellow farmers prior to adopting or using any new practices/technologies. Farmers were sceptical about technology unless other farmers used these technologies successfully on their farm. Topography/climatic variability were the other constraint due to varying climatic conditions in different regions.

CONCLUSION

Majority of NICRA interventions appeared to be promising in terms of imparting resilience. PAU-KVKs demonstrated technologies related to natural resource management, crop production, soil health and livestock to improve livelihood of farmers. Survey findings showed that adoption of agricultural practices depended on location, infrastructure, market forces and social preferences. A favourable influence of the exhibited technologies on social and economic aspects of farmer's life was witnessed in NICRA village. Psychological mindset of farmers played a greater role in the adoption of any intervention. It has been seen that there was increased cooperation and cohesiveness among the farmers of the NICRA villages after the introduction and implementation of the project. More efforts are required to demonstrate the region-specific climate-resilient technologies and extend their benefits to a larger number of farmers.

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